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UNDERGROUND STORAGE OF NATURAL GAS IN ILLINOIS

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ABSTRACT

Natural gas from the Mid-Continent and Gulf Coast regions is being stored underground in Illinois in six areas as of January 1, 1961, and similar storage projects are planned in at least five other areas. The storage reservoirs are of two main types: 1) "aquifers," or those that originally contained only water, and 2) those that contained oil or gas as well as water.

Gas storage reservoirs now in use have an estimated total capacity of 184 billion cubic feet.

Underground storage facilities perform a vital function in making gas available to consumers in the necessary quantities at times of high demand and at a cost lower than that of direct pipeline delivery from the distant sources. It is thus possible to serve many more consumers than could be served without the use of underground storage.

INTRODUCTION

Natural gas from the Mid-Continent and Gulf Coast regions is being stored underground in Illinois in six areas as of January 1, 1961, and similar storage projects are planned in at least five other areas. The storage reservoirs are of two main types: 1) "aquifers," or those that originally contained only water, and 2) those that contained oil or gas as well as water.

Underground storage facilities perform a vital function in making gas available to consumers in the necessary quantities at times of high demand and at a cost lower than that of direct pipeline delivery from the distant sources. It is thus possible to serve many more consumers than could be served without the use of underground storage.

Natural gas has been stored underground in Illinois since 1953, and the use of underground storage has been steadily increasing. In 1951 the Illinois Commerce Commission consulted the Illinois State Geological Survey about the feasibility of underground storage, and ever since then the Survey has kept in touch with developments and has continued to study the geology of the storage sites. The Survey has assisted by discussions with the staffs of the Illinois Commerce Commission and the companies concerned and by attending hearings before the commission. Much information on the geology and engineering of the storage projects is contained in the testimony by geologists and engineers in transcripts of the hearings on file with the commission.

Beginning in June 1959, the Research Committee of the Interstate Oil Compact Commission undertook a study of the underground storage of natural gas in the United States. At subsequent meetings of the research committee in December 1959,

June 1960, and December 1960, Illinois and about 25 other states presented progress reports. The Illinois report included developments in underground gas storage up to December 1, 1960. The present report includes available information up to January 1, 1961.

The six areas in which gas is being stored underground in Illinois are Herscher in Kakakee County (no. 1 on index map, fig. 1); Cooks Mills in Coles County (4); Troy Grove in LaSalle County (2); Waterloo in Monroe County (9); Gillespie in Macoupin County (7); and Freeburg in St. Clair County (10). Similar gas storage operations are planned in at least five other areas: Mahomet in Champaign County (map no. 3); Crescent City in Iroquois County (5); Waverly in Morgan County (6); St. Jacob in Madison County (8); and North Tilden in Washington and St. Clair Counties (11).

The Herscher and Cooks Mills storages by the Natural Gas Storage Company of Illinois and the future Mahomet storage by the Peoples Gas Light and Coke Company are for supplying the City of Chicago. The Troy Grove and future Crescent City operations by the Northern Illinois Gas Company are for supplying many municipalities in northern Illinois outside of Chicago.

The Northern Illinois Gas Company and others share in the use of the Herscher storage with the Natural Gas Storage Company of Illinois, a subsidiary of the Peoples Gas Light and Coke Company of Chicago. The Gillespie and Freeburg storages and the future North Tilden storage by the Illinois Power Company are for supplying gas to local communities in southwestern Illinois. The Waterloo and future St. Jacob storages by the Mississippi River Fuel Corporation are for the supply of St. Louis, Missouri, and surrounding communities.

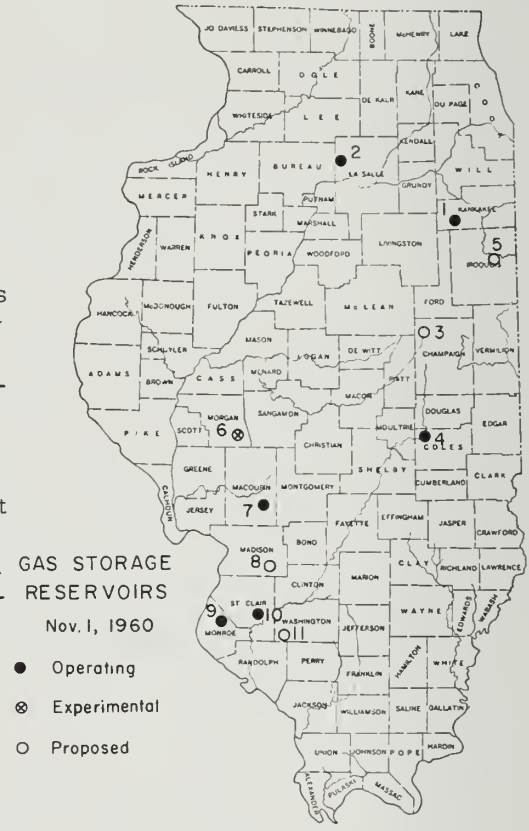

Fig. 1 – Location of underground gas storage reservoirs in Illinois.

1 Herscher	7 Gillespie
2 Troy Grove	8 St. Jacob
3 Mahomet	9 Waterloo
4 Cooks Mills	10 Freeburg
5 Crescent City	11 North Tilden
6 Waverly	

The following individuals have been especially helpful in furnishing the basic data and in suggesting revisions and corrections to the preliminary report dated December 1, 1960: O. C. Davis, W. L. Clark, and K. R. Larson of the Natural Gas Storage Company of Illinois; Joseph Gauthier, Harold R. Schwalm, and C. G. Nelson of the Northern Illinois Gas Company; Kenneth Robertson of the Illinois Power Company; R. B. Harkins of the Panhandle Eastern Pipeline Company; and Carl Temple of the Mississippi River Fuel Corporation. I also am indebted to Carl W. Sherman, Head of the Petroleum Engineering Section of the Illinois State Geological Survey, who assisted in preparing this report.

The underground reservoirs that originally contained water or salt water, commonly referred to as aquifers, include the reservoirs of largest capacity in Illinois - for example, Herscher. Those that originally contained gas or oil or both, along with some water, include several gas reservoirs where the wells were capable of producing gas but where the gas has not been marketed - for example, Cooks Mills and Freeburg. In these storage reservoirs the injected gas mixes with the gas originally in the reservoir, and during the initial stage the gas withdrawn is a mixture of both.

Estimated capacities of operating gas storages in Illinois, as of January 1, 1961, are shown in table 1. Volumes are given in thousands of cubic feet (Mcf).

TABLE 1 - ESTIMATED CAPACITIES OF OPERATING GAS STORAGES IN ILLINOIS DECEMBER 1, 1960

	Working gas capacity Mcf	Cushion gas Mcf	Total Mcf
Herscher Galesville	45,000,000	45,000,000	90,000,000
Herscher Mt. Simon (Herscher total 157 million Mcf)	39,000,000	28,000,000	67,000,000
Troy Grove	11,000,000	7,000,000	18,000,000
Cooks Mills	1,004,000	984,000	1,988,000
Gillespie	31,000	115,000	146,000
Waterloo	413,000	100,000	513,000
Freeburg	1,810,000	4,590,000	6,400,000
	98,258,000	85,789,000	184,047,000

FUTURE DEVELOPMENT

Because several companies are actively seeking geologic structures that are suitable for gas storage, it seems likely that additional storage projects will be undertaken during the coming year. Some of the companies engaged in this work and some of their areas of exploration are: Natural Gas Storage Company of Illinois in McLean and adjacent counties; Northern Illinois Gas Company in northeastern Illinois; Central Illinois Light Company in Peoria, Woodford, and Tazewell Counties; Illinois Power Company in Tuscola region, Douglas County; and Central Illinois Public Service Company in Ashmore South pool, Cumberland and Clark Counties.

HERSCHER GAS STORAGE FIELD

Operator: Natural Gas Storage Company of Illinois.

Location: Kankakee County, 12 miles west-southwest of the city of Kankakee and half a mile south of Herscher village.

Geologic Investigations: The presence of an anticline in the subsurface bedrock has been known since the early 1900's from the drilling of several small oil wells, described by L. F. Athy (1928, p. 110). A structure contour map by D. J. Fisher (*in* Athy, 1928, fig. 27, p. 75) showing elevation of the St. Peter Sandstone in part of northeastern Illinois reveals the Herscher Anticline. In 1951, the Natural Gas Storage Company of Illinois undertook to outline the structure in greater detail and to determine whether suitable porous strata and caprock were present.

In 1952, 104 shallow test wells were drilled to the Galena Formation and four deep tests were drilled and cored through the Galesville Sandstone.

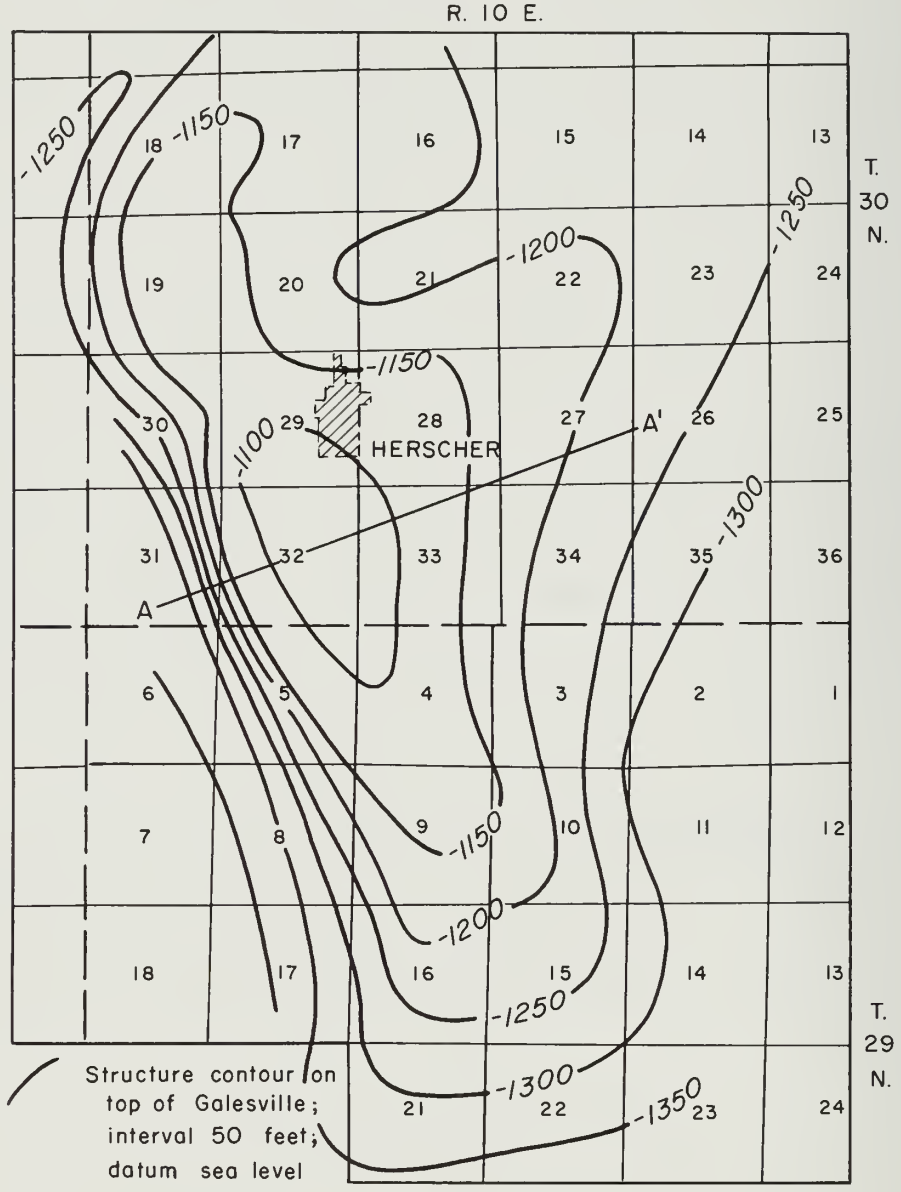

Fig. 2 - Structure of the Galesville Sandstone at the Herscher gas storage dome. Contours after map by the Natural Gas Storage Company of Illinois.

The size and shape of the structure is shown in figure 2, a contour map of the top of the Galesville Sandstone, which was to be the gas storage reservoir. The cores provided the information on porosity and permeability of the Galesville needed to determine its suitability as a gas storage reservoir and the adequacy of the caprock immediately overlying the reservoir.

Test drilling to determine the feasibility of deeper gas storage to supplement the storage in the Galesville reservoir was done in 1957. The information obtained indicated the likelihood of a good storage in the Mt. Simon Sandstone at an approximate depth of 2400 feet. A structure map of the Mt. Simon Sandstone is shown in figure 3, and the relationship of the Galesville and Mt. Simon Sandstones is shown in the cross section, figure 4.

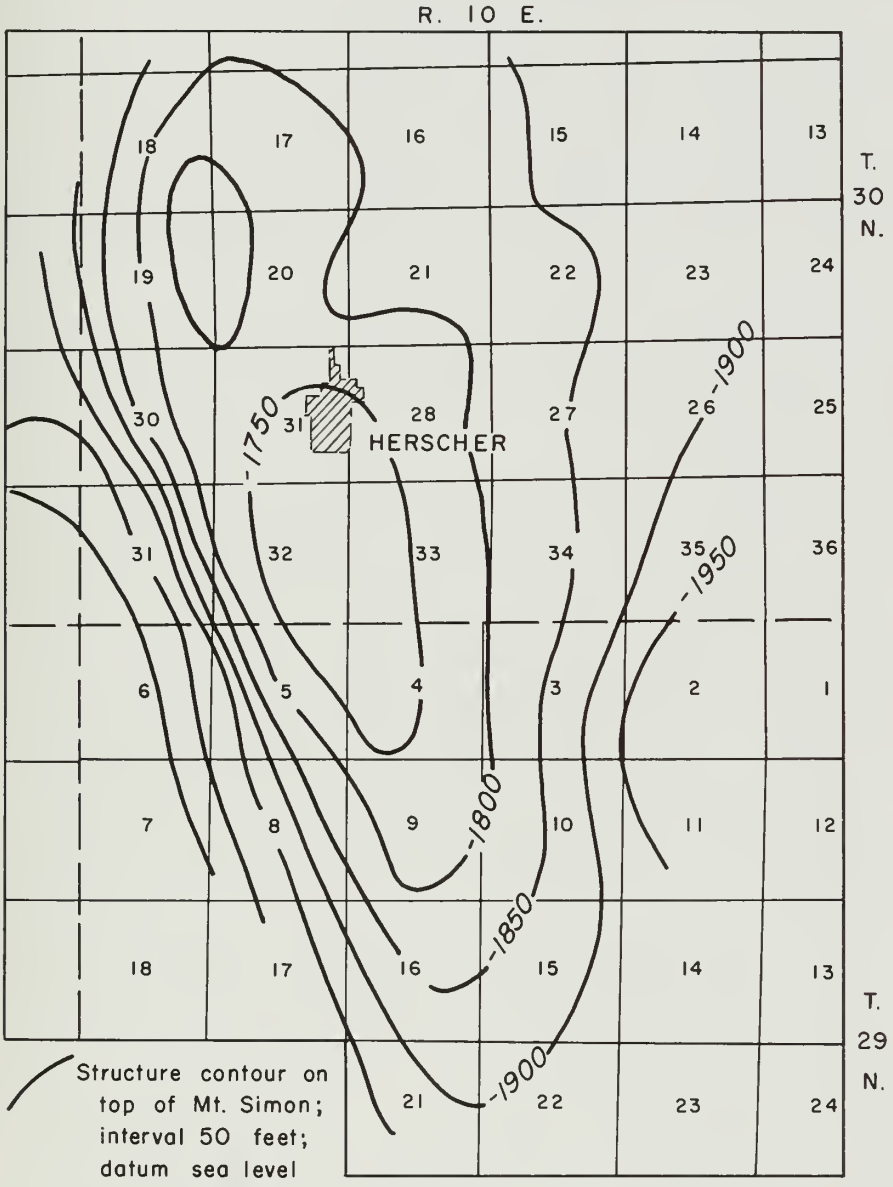

Fig. 3 - Structure of the Mt. Simon Sandstone at the Herscher gas storage dome. Contours after map by the Natural Gas Storage Company of Illinois.

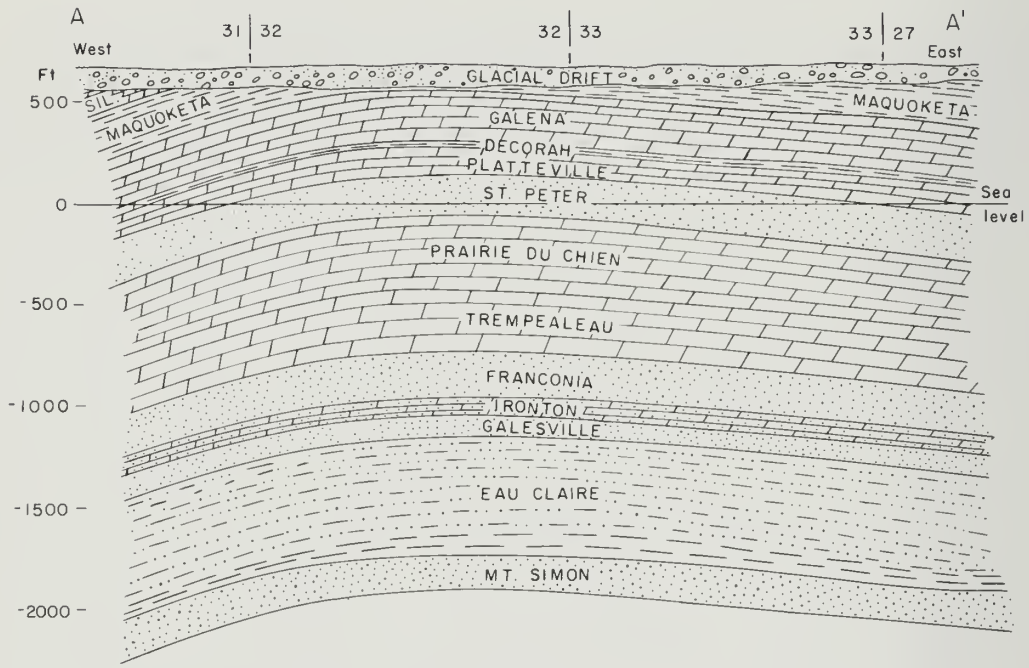

Fig. 4 - West-east cross section of Herscher dome, vertical exaggeration x 3.3 (location shown on fig. 2).

The following is quoted from "The Story of the Herscher Dome," by the Natural Gas Storage Company of Illinois (1957, p. 4-5).

"A total of 21 injection-withdrawal wells were completed in the Galesville Sandstone on the crest of the structure, using 660-foot spacing.

"Thirteen observation wells were drilled on the structure to the top of the reservoir at down-dip positions on the flanks to observe water levels and follow the movement and effect of the gas bubble that was to be created.

"Gas injection was started on April 1, 1953, using two 150 HP compressors with a total capacity of 15 MMcf* per day. Initially, the five structurally highest wells were used for injecting gas into storage. Gas for storage operations was piped from a point on the Texas Illinois system later renamed Natural Gas Pipeline Company of America near Dwight, Illinois, through a single 30-inch line. A 10,000 HP compressor station and a dehydration plant with 300 MMcf per day capacity were constructed to handle the gas on injection and withdrawal. The capacity of the dehydration plant has since been increased to 430 MMcf per day. The main plant was put into service on July 1, 1953. Injection rates were stepped up to approximately 200 MMcf per day with the large units when the main plant was put into operation."

During the last week in July 1953, four months after gas injection was started, gas began to leak into one of the shallow water wells in the town of Herscher. Soon gas was leaking into all 33 village water wells. Gas injection was stopped one week after leakage had been detected. A search for the cause of the leakage was then undertaken by a variety of methods, but to date the cause has not been determined with certainty. However, it was found possible to control the leakage by the following four methods:

* Millions of cubic feet.

1) By limiting pressure during the injection cycle. At first, the injection pressure was limited to the natural formation pressure above the Galesville aquifer, but later the differential pressure was controlled between the Galesville gas bubble and the overlying Oneota Formation.

2) By recycling the gas from vent wells in the Galena and St. Peter Formations to the Galesville reservoir.

3) By pressurization of the Ironton Formation above the Galesville but below the Oneota (see fig. 4) by injection of water.

4) By relieving pressure in the Galesville reservoir through withdrawal of water from perimeter wells outside of the gas bubble. (This water is used for pressurization of the higher formations.)

The total amount of leakage from August 1, 1953, to October 2, 1955, when a recycling system began operation, was 2,947 million cubic feet at an average rate of 3.6 million cubic feet per day. Success of the control methods is indicated in the gradual downward trend in the amounts of gas recycled daily by years shown in table 2.

TABLE 2 - DAILY AVERAGES OF GAS RECYCLED FROM THE GALENA AND ST. PETER FORMATIONS INTO THE HERSCHER GALESVILLE RESERVOIR IN MILLIONS OF CUBIC FEET

	Galena Formation			St. Peter Formation		
	Average	Maximum	Minimum	Average	Maximum	Minimum
1954						
1955	(Recycling system began Oct. 2, 1955; a loss to that date was 2.947 billion cu. ft.)			(Wells first drilled in early part of 1956)		
1956	12.4	15.4	9.8	3.6	4.4	2.7
1957	12.6	15.4	9.1	4.3	5.0	3.8
1958	13.2	15.2	10.6	3.8	4.5	3.1
1959	9.1	12.4	5.7	3.7	4.3	3.2
1960	10.3	20.2	9.9	3.2	2.9	0.9

NOTE: The above values are based on average daily recycled volumes for months.

The following table shows amounts of gas injected into and withdrawn from the Herscher Galesville reservoir, by years, and the maximum daily withdrawals by years at times of severe cold weather.

TABLE 3 - HERSCHER GALESVILLE RESERVOIR
(in Mcf)

Year	Injected	Withdrawn	Inventory end of year	Peak day withdrawal
1953	11,885,137	99,044	11,984,181	61,482
1954	6,178,390	340,111	17,822,460	157,777
1955	4,337,904	1,864,920	20,295,444	368,060
1956	6,490,803	1,539,393	25,246,854	414,996
1957	7,041,143	2,996,821	29,291,176	291,159
1958	9,124,414	8,528,832	29,886,758	411,467
1959	9,698,097	6,050,945	33,533,910	429,633
1960	7,826,486	7,165,722	34,194,674	473,391

Similar information is shown in the next table for the Herscher Mt. Simon reservoir.

TABLE 4 - HERSCHER MT. SIMON RESERVOIR
(in Mcf)

Year	Injected	Withdrawn	Inventory end of year	Peak day withdrawal
1957	21,667	--	21,667	None
1958	3,750,320	87,894	3,684,093	25,342
1959	6,034,283	364,495	9,353,881	52,098
1960	7,456,393	733,989	16,076,285	65,410

Although the capacity of the Galesville (fig. 2) and Mt. Simon (fig. 3) reservoirs in the Herscher dome is less than originally anticipated, the total operation will undoubtedly be economically successful. The total investment in the Herscher storage project as of August 31, 1960,was $32,240,864, including the cost of cushion gas but not of microwave installations and some minor items. The total cushion gas investment is $6,929,356, which includes $4,224,016 for the Galesville and $2,705,340 for the Mt. Simon. When these figures are compared with the 200 million dollars that would be required to build and equip another 30-inch pipeline from Texas (necessary to meet winter peak loads without storage), the advantage of the underground storage facilities is clearly evident.

The location of the principal pipelines which bring gas from the Mid-Continent and the Gulf Coast areas into Illinois is shown on the map (fig. 5). This map also shows the location of the Herscher and Cooks Mills gas storages and the future Mahomet gas storage with the pipeline connections to them.

TROY GROVE GAS STORAGE FIELD

Operator: Northern Illinois Gas Company.

Location: LaSalle County, midway between Mendota and LaSalle and near Troy Grove.

Geologic Investigations: The Northern Illinois Gas Company consulted the Illinois State Geological Survey in 1956 in regard to possible sites for underground gas storage in the northern part of Illinois. The available data suggested a search for a structural closure north of LaSalle along the axis of the LaSalle Anticline. Test core drilling that was begun in January 1957 gave data which defined the Troy Grove dome (fig. 6), an asymmetrical, east-west trending anticline with 120 feet of closure on the Cambrian. The top of the Mt. Simon Sandstone and two basal sandstones of the Eau Claire Formation overlying it are used for gas storage. Dense shales and argillaceous dolomites form the caprock over these sandstones.

Tests of core samples indicated porosities in the storage sands ranging from 15 to 18 percent. Many samples of the caprock showed permeabilities below 10^{-6} millidarcies.

The test drilling indicated the presence of several faults, four of which are shown in figures 6 and 7. The displacement ranges from 15 to 160 feet.

In June 1958, the Illinois Commerce Commission issued a certificate of convenience and necessity authorizing Northern Illinois Gas Company to test and

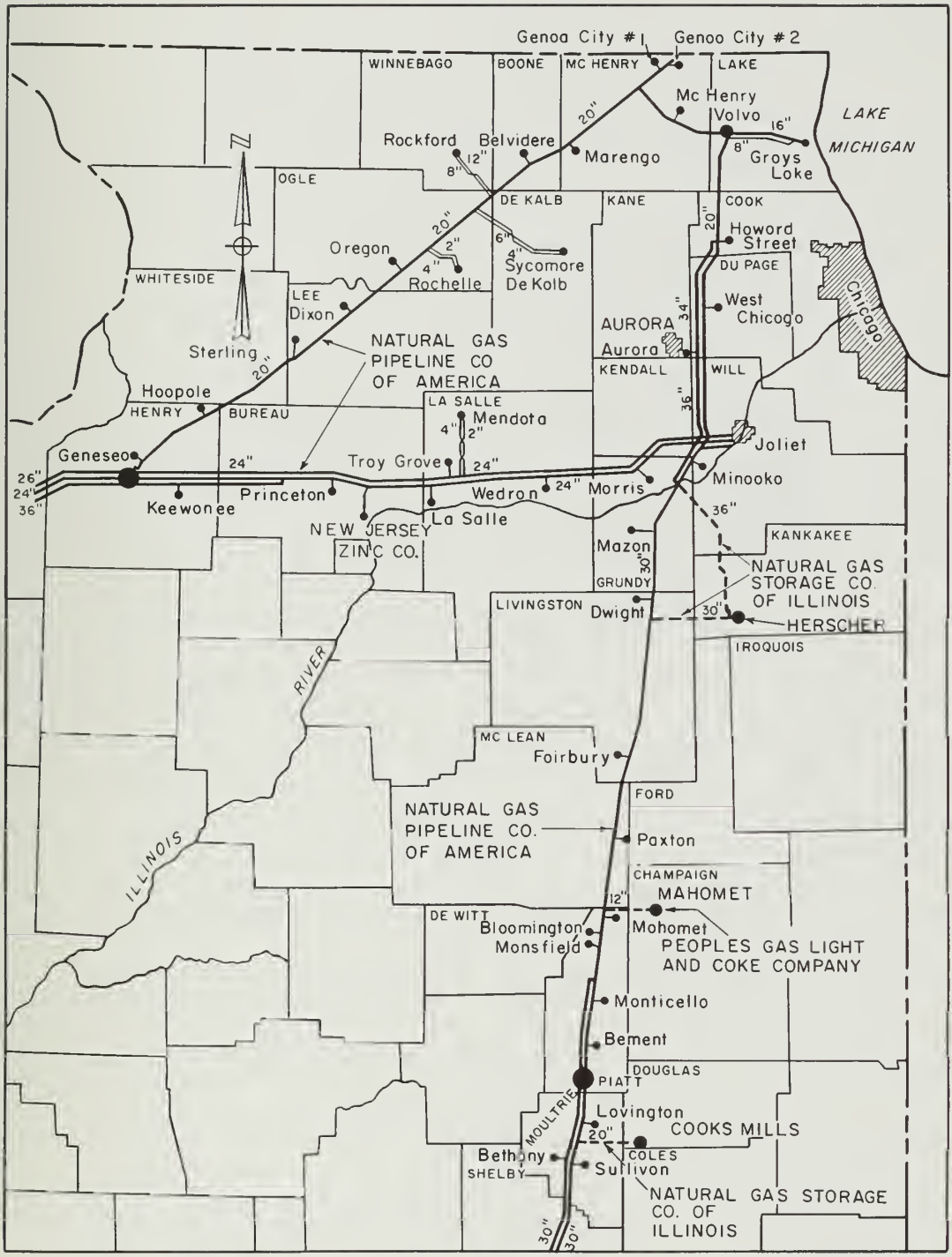

Fig. 5 - Portion of the state of Illinois showing location of pipelines of Natural Gas Pipeline Company of America, Natural Gas Storage Company of Illinois, and Peoples Gas Light and Coke Company. (Courtesy of Peoples Gas Light and Coke Company.)

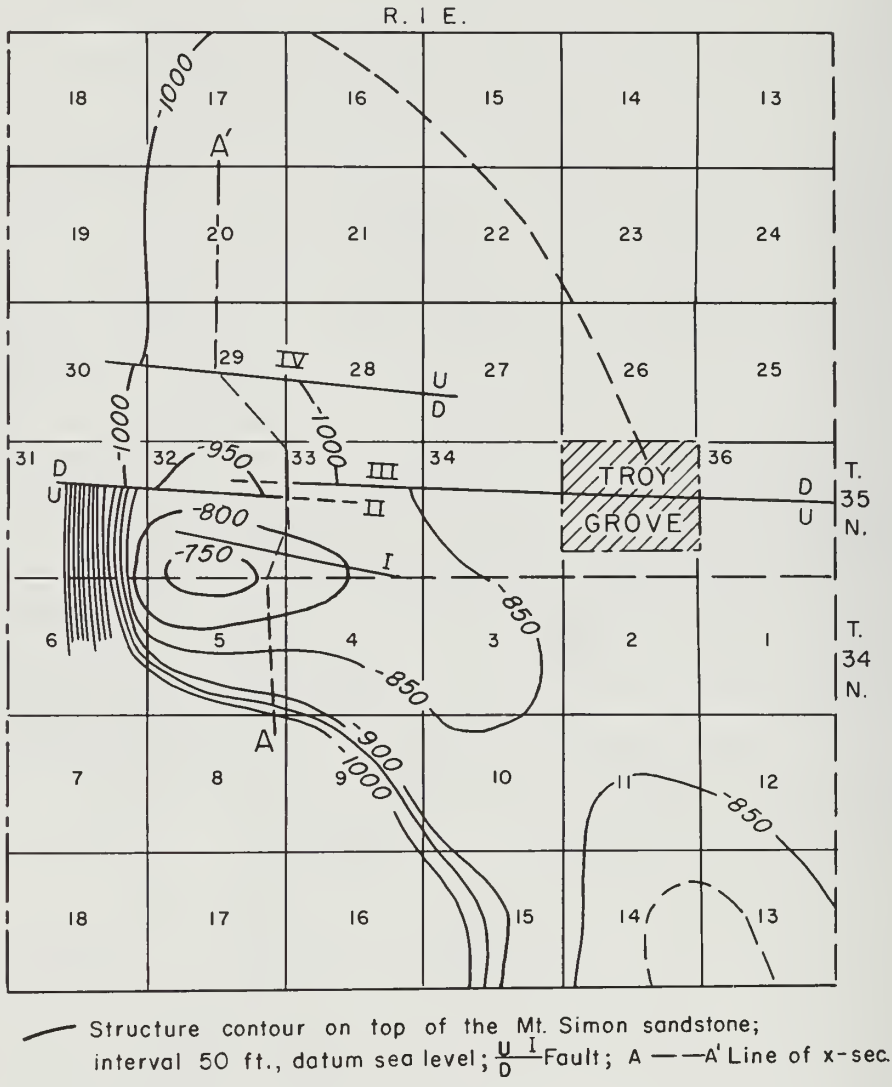

Fig. 6 - Structure of top of the Mt. Simon Sandstone at the Troy Grove Storage project, LaSalle County, Illinois (by Northern Illinois Gas Company).

develop the structure. Gas injection into the Mt. Simon Sandstone was started in July 1958. Withdrawal of gas on a test basis began in December 1959.

Gas is brought for injection into the Troy Grove storage reservoir by a 16-inch diameter lateral pipeline running north from the Natural Gas Pipe Line Company of America's trunk line near LaSalle.

The working gas capacity of the storage sands is estimated to be 11 billion cubic feet and the cushion gas capacity 7 billion cubic feet, making a total capacity of 18 billion cubic feet.

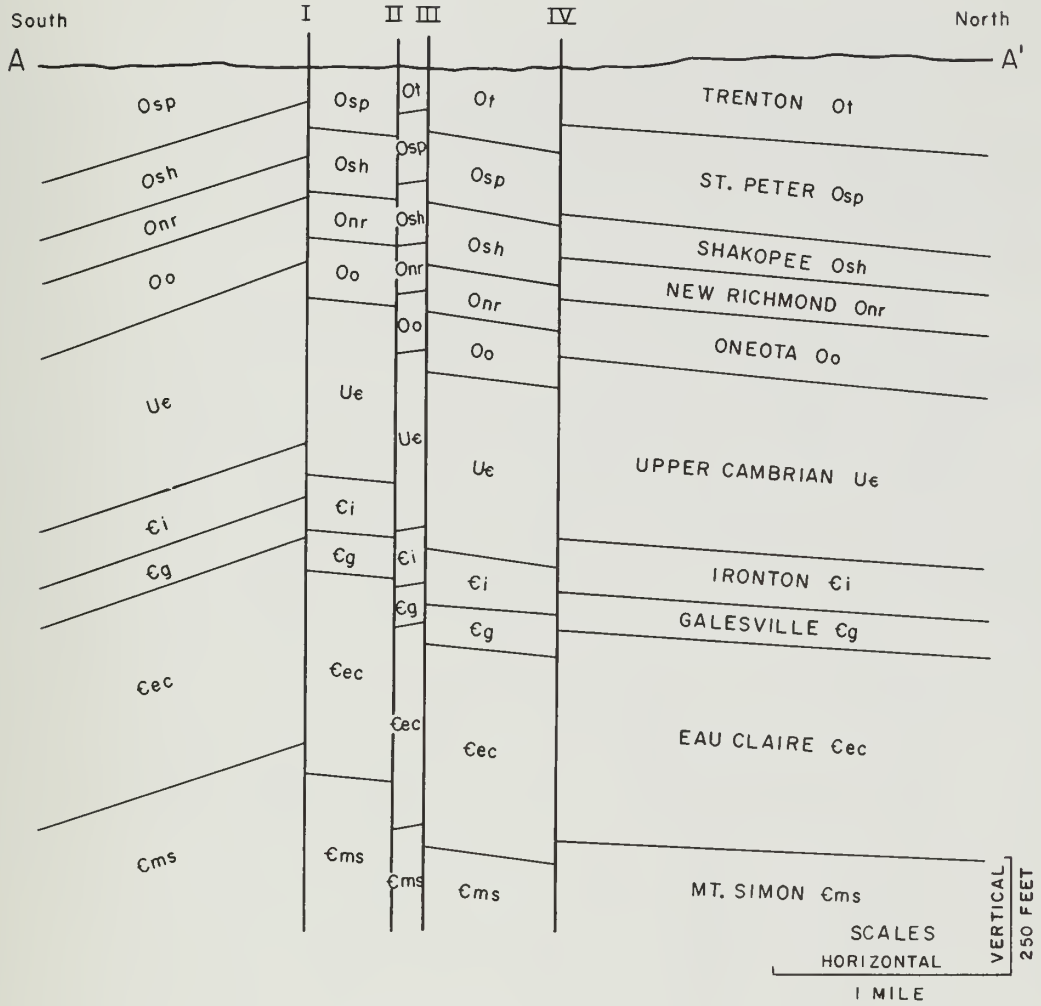

Fig. 7 - Cross section of Troy Grove aquifer (by Northern Illinois Gas Company).

Observations at the wells on both sides of the east-west faults indicated that where sandstone is in contact with sandstone, migration takes place freely across the faults, but there was no indication of upward migration of gas along the faults. Thus, it appears that the Troy Grove dome will be an effective gas storage reservoir.

MAHOMET DOME

Operator: Peoples Gas Light and Coke Company, Chicago.

Location: Western part of Champaign County.

Geologic Investigations: In their search for structures suitable for underground storage of gas, the Union Hill Gas Company, a subsidiary of the Peoples Gas Light and Coke Company of Chicago, investigated parts of the LaSalle Anticlinal Belt. In 1959 and 1960, they concentrated on an area between Mahomet and Gibson City.

The following is quoted from the testimony by a company geologist before the Illinois Commerce Commission:

"The presence of a large anticlinal structure in the northwestern corner of Champaign County, Illinois, has been confirmed by a detailed exploration program recently conducted by Union Hill Gas Storage Company. The principal structural feature is a domal anticlinal fold with a north-south major axis and approximately 150 feet of closure. No evidence of faulting has been encountered and the asymmetry of the structure, viewed in an east-west direction, is a characteristic exhibited by most large subsurface folds in northern Illinois along the LaSalle Anticlinal Belt.

"The St. Peter Formation, encountered at an average depth of 1600 feet, is a porous and permeable sand, overlain by impermeable limestones, and suitable for the storage of natural gas.

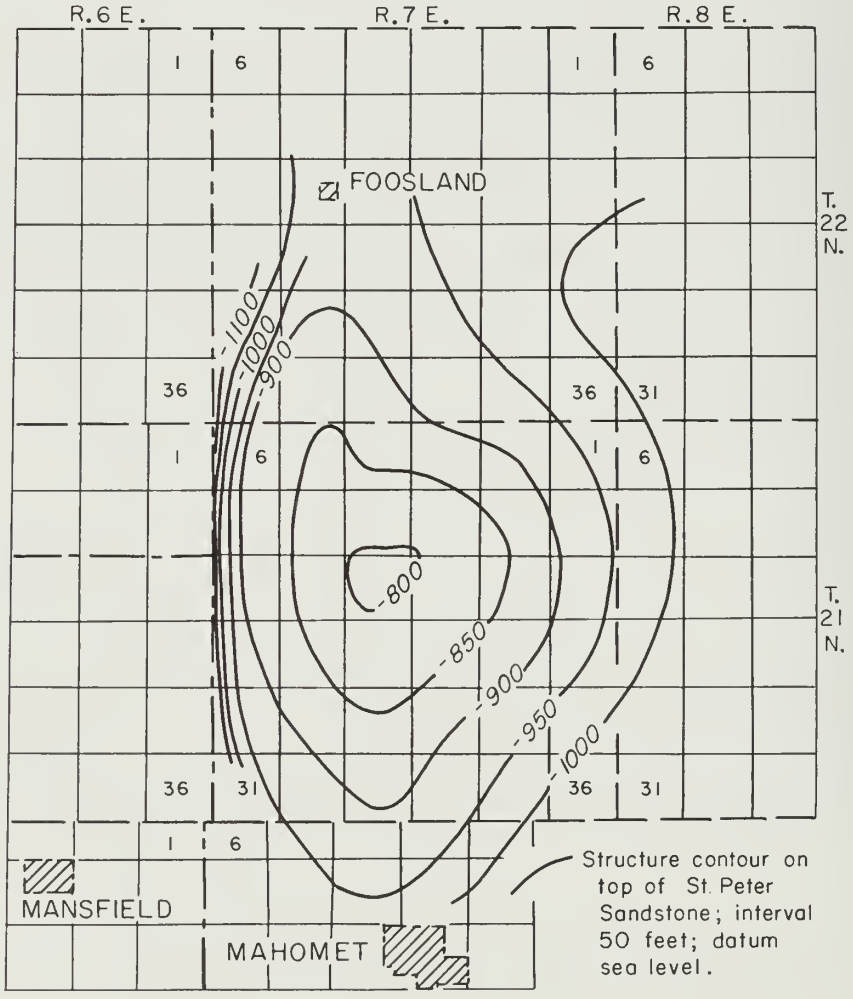

Fig. 8 - Structure of the St. Peter Sandstone at the Mahomet dome, Champaign County, Illinois (after map by Peoples Gas Light and Coke Company, Chicago).

"Underground storage of natural gas in the St. Peter Formation will in no way interfere with the local ground-water resources. No minable coals, minerals, nor commercial accumulations of either oil or natural gas have been encountered in any of the geological formations within the proposed storage area."

After several hearings, the Illinois Commerce Commission granted a certificate of convenience and necessity to Peoples Gas Light and Coke Company in August 1960 to develop the structure for gas storage. Injection on a pilot scale is expected to begin in the spring of 1961.

COOKS MILLS STORAGE AREA

Operator: Natural Gas Storage Company of Illinois

Location: Part of Cooks Mills Consolidated Pool in Coles County, Illinois.

Geologic Investigations: The Cook Mills Consolidated oil pool in Coles and Douglas Counties, Illinois, was discovered in 1941, but its major development did not take place until 1954. Oil and gas are produced from the Cypress, Aux Vases, and Spar Mountain Sandstones and from the Ste. Genevieve Limestone, all of Mississippian age. In one part of the field several wells produced gas from the Cypress, and the Natural Gas Storage Company of Illinois bought the storage rights and the gas in place. The domal structure in this area is shown in figure 9 and has been described by Whiting (1959).

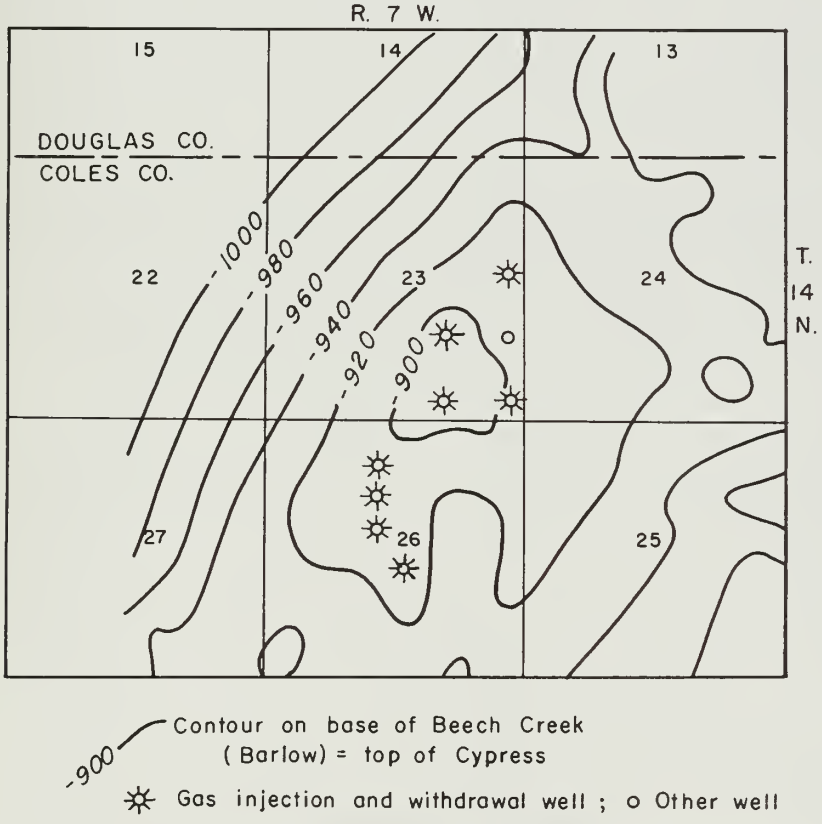

Fig. 9 - Part of Cooks Mills Consolidated pool (after map by Natural Gas Storage Company of Illinois, June 1960).

Use of the Cypress Sandstone reservoir for storage in the Cooks Mills area began in 1958. At the end of that year, the reservoir contained 775,160 Mcf "top" storage gas and 993,736 Mcf cushion gas, or a total of 1,768,896 Mcf. At the end of 1959, the reservoir contained 1,003,880 Mcf top and 993,736 Mcf cushion gas, a total of 1,997,616 Mcf. At the end of 1960 the reservoir contained 2,120,373 Mcf. Peak daily withdrawal from the Cypress reservoir in the Cooks Mills field in 1960 was 29,284 Mcf.

Table 5 gives monthly injections and withdrawals for the Cooks Mills field for the year 1959.

TABLE 5 - COOKS MILLS GAS STORAGE, 1959
(In Mcf, as metered at 14.65 psia)

	Injection	Withdrawal	Inventory
December 1958			1,768,896
January 1959	-	183,375	1,585,521
February	-	384,589	1,200,932
March	-	379,928	821,004
April	-	-	821,004
May	-	-	821,004
June	205,250	-	1,026,254
July	390,892	-	1,417,146
August	374,446	-	1,791,592
September	90,826	29,810	1,852,608
October	145,008	-	1,997,616
November	-	-	1,997,616
December	-	-	1,997,616

Gas for injection into the Cooks Mills storage reservoir is brought through a 20-inch lateral line, approximately 20 miles long, from the Natural Gas Pipe Line Company of America's 30-inch transmission line from Texas. The lateral also is used for withdrawal of gas from storage (see fig. 5).

Table 6 gives a monthly summary of gas injections and withdrawals for 1960.

TABLE 6 - COOKS MILLS GAS STORAGE, 1960
(In Mcf, as metered at 14.65 psia)

	Injection	Withdrawal	Inventory
December 1959			1,997,616
January 1960	-	240,511	1,957,105
February	-	60,703	1,696,402
March	-	909	1,695,493
April	-	173	1,695,320
May	-	78	1,695,242
June	-	19	1,695,223
July	427,108	-	2,122,331
August	-	16	2,122,315
September	-	92	2,122,223
October	-	377	2,121,846
November	-	588	2,121,258
December	-	885	2,120,373

CRESCENT CITY DOME

Operator: Northern Illinois Gas Company.

Location: Between Crescent City and Watseka, Livingston County.

Geologic Investigations: Following an examination of well cuttings in the files of the Illinois State Geological Survey, Northern Illinois Gas Company commissioned a gravity survey in Livingston County in the spring of 1959. A gravity anomaly was found just west of Watseka. In June 1959, a small drilling rig was

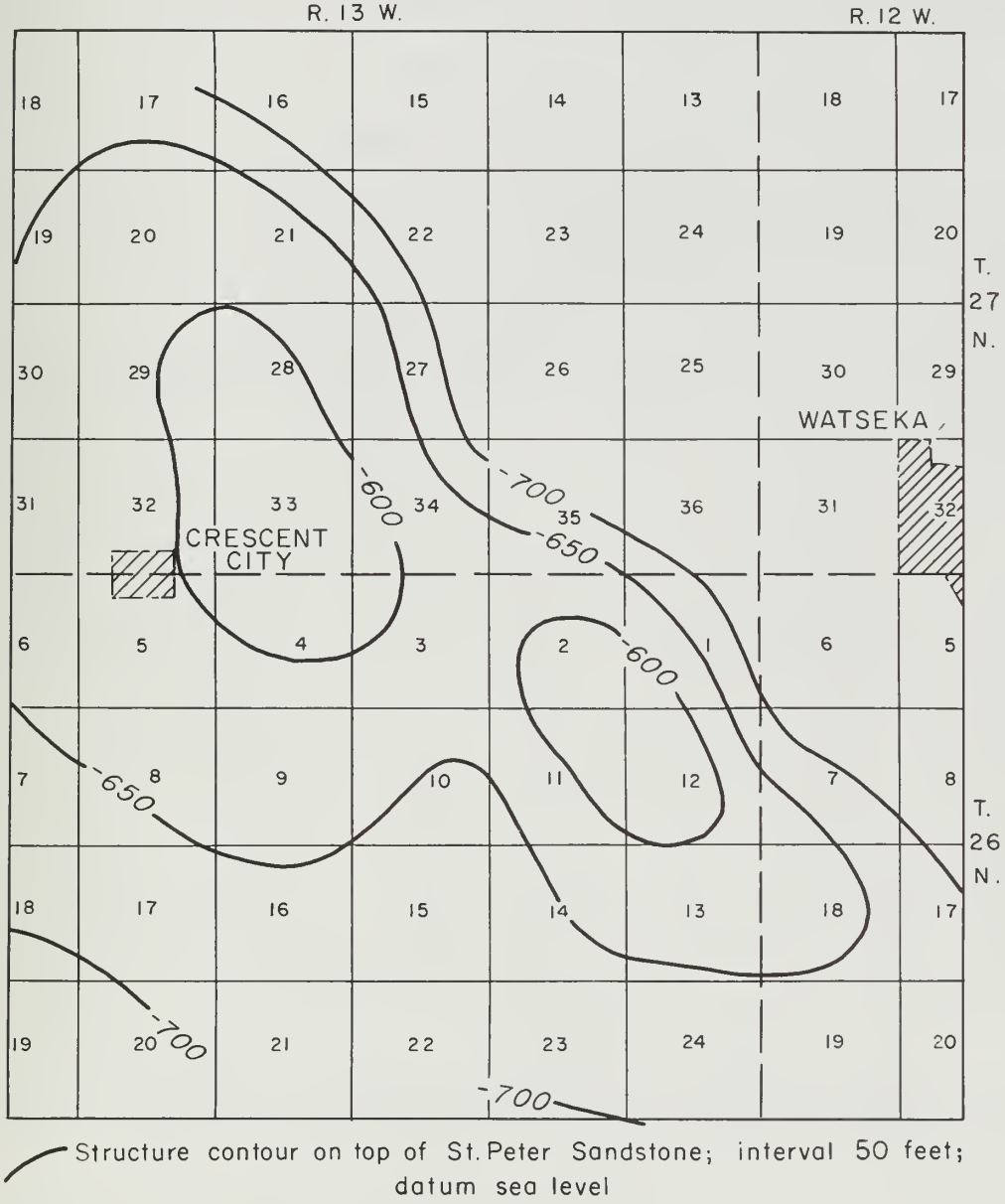

Fig. 10 - Crescent City dome, Livingston County, Illinois (after map by Northern Illinois Gas Company, October 26, 1960).

moved into the area,and by February 1960 some 22 structure test wells had been completed, 20 of which penetrated the Galena Limestone. Further drilling was carried on until by October 26, 1960, about 70 structure test wells had been completed. A structure contour map of the Crescent City dome based on the data from drilling is shown in figure 10.

During July, August, and September 1960, the Illinois Commerce Commission held four hearings on the application of the Northern Illinois Gas Company for a certificate of convenience and necessity to test, develop, operate, and maintain an underground gas storage operation in the Crescent City area, Livingston County. The case was still pending at the end of 1960.

WAVERLY DOME

Operator: Panhandle Eastern Pipeline Company.

Location: Morgan County, Illinois, Southeast Township, T. 13 N., R. 8 W.,

Geologic Investigations: A structure map of Pennsylvanian strata in the vicinity of Jacksonville, published in 1923 (Collingwood, fig. 2, p. 21) shows an anticlinal nose trending southwest-northeast in T. 12 N., R. 8 W. and R. 7 W. During succeeding years deeper drilling found some gas and oil shows in Devonian strata. The structure of the Waverly dome is shown in figure 11.

In the early 1950's, the Panhandle Eastern Pipeline Company acquired gas storage rights and in 1954 began injecting gas into the St. Peter Sandstone,which in this area contains salt water. The record of amounts of gas injected by months and by years is shown in table 7.

TABLE 7 - WAVERLY GAS STORAGE INPUTS
(In Mcf)

	1954	1955	1956	1957	1958	1959	1960
Jan.		0	0	0	0	0	0
Feb.		0	0	0	22,043	0	0
March		0	0	0	90,236	0	0
April	178,589	0	0	65,243	304,492	0	0
May	474,908	0	0	87,169	232,521	0	0
June	555,877	0	33,796	85,328	197,988	0	0
July	529,266	0	84,081	199,866	186,775	0	0
Aug.	104,367	0	91,492	237,156	191,353	0	0
Sept.	149,766	0	122,210	201,495	182,842	0	0
Oct.	0	0	166,499	198,674	188,458	0	0
Nov.	0	0	64,705	180,216	148,212	0	0
Dec.	0	0	0	52,281	0	0	0
Total	1,992,773	0	562,783	1,307,428	1,744,920	0	0

Up to date, there is no record that any of the injected gas has been recovered. A certificate application for authority to conduct productivity testing operations is in the hands of the Federal Power Commission.

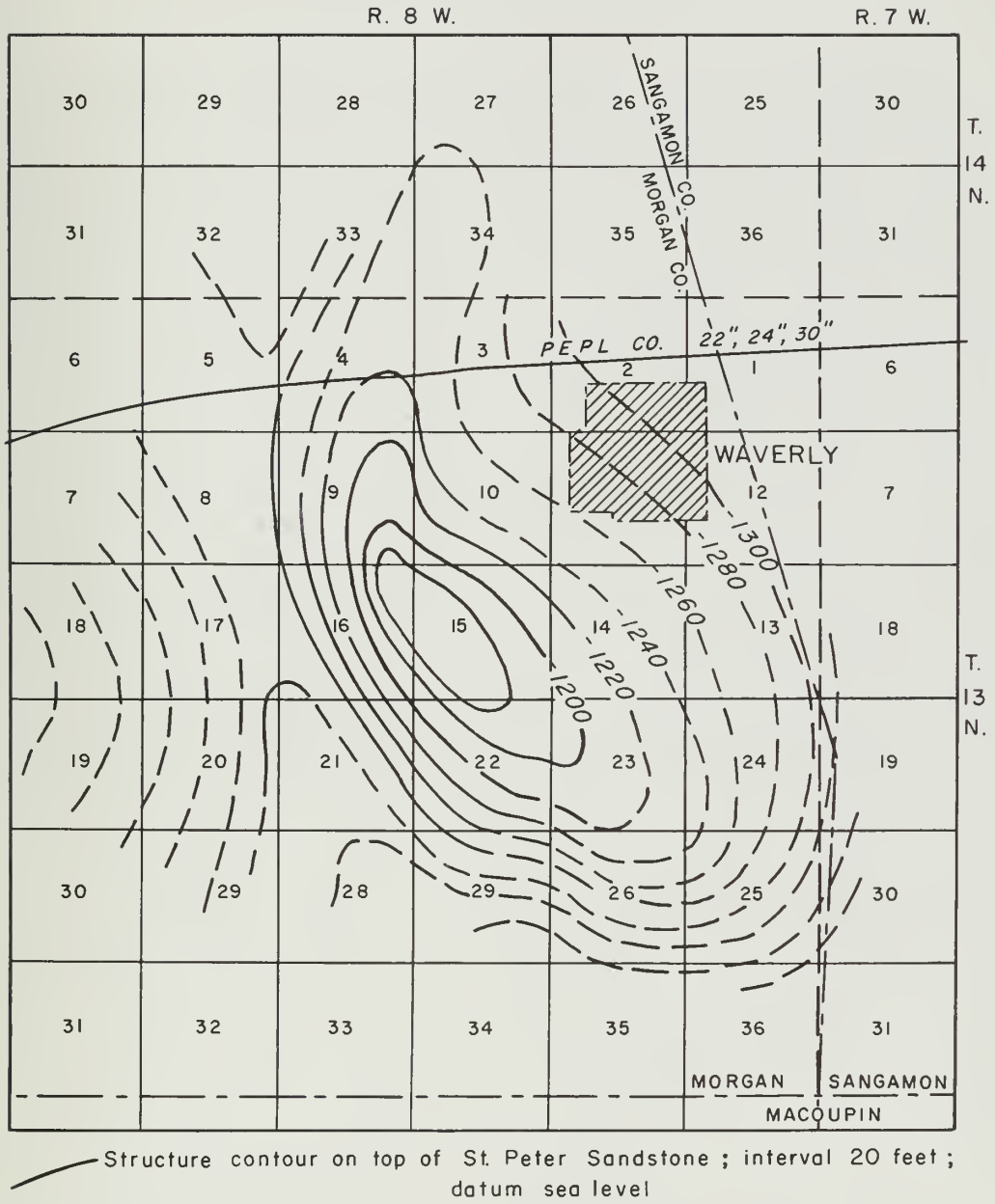

Fig. 11 - Structure of the top of the St. Peter Sandstone, Waverly dome, Morgan County, Illinois (after map by Panhandle Eastern Pipe Line Company).

GILLESPIE GAS STORAGE FIELD

Operator: Illinois Power Company

Location: About two miles east of Gillespie village, Macoupin County.

History: The Gillespie Benld Gas Field was discovered in 1923 and was abandoned in 1935 after producing a total of approximately 136 million cubic feet of gas from a Pennsylvanian sandstone lens at the approximate depth of 540 feet. On September 9, 1958, the Illinois Commerce Commission granted to Illinois Power Company a certificate of convenience and necessity for the development, construction, operation, and maintenance of a natural gas storage reservoir in the depleted gas field.

The location of wells for injection and withdrawal of gas and the thickness of gas sand in each well are shown in figure 12.

The amounts of gas injected and withdrawn by months during 1960 are given in table 8.

TABLE 8 - GILLESPIE GAS STORAGE

1960	Injected Mcf	Withdrawn Mcf
Jan.	1,031	1,164
Feb.	0	12,029
March	18,193	14,164
April	6,852	396
May	1,977	0
June	0	0
July	0	0
Aug.	0	0
Sept.	933	0
Oct.	4,832	1,962
Nov.	0	24
Dec.	3,308	259
Total	37,126	29,998

The total amount of gas injected into the Gillespie storage reservoir in 1958 was 100,000 Mcf and for the year 1959 43,531 Mcf. The amount withdrawn in 1959 was 10,423 Mcf.

The amount injected in 1960 was 37,126 Mcf and the amount withdrawn was 29,998 Mcf.

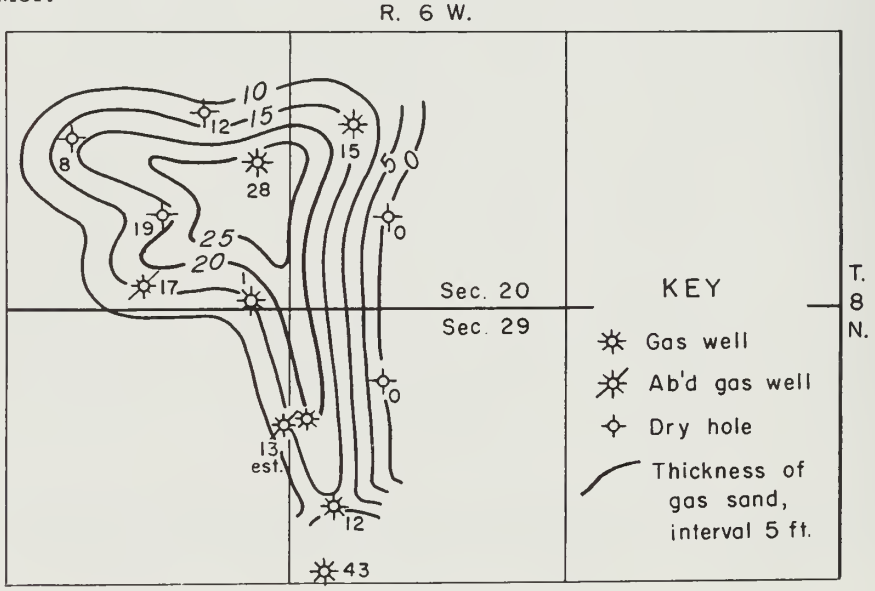

Fig. 12 - Gillespie gas storage field, Macoupin County, Illinois (after map by Illinois Power Company, August 28, 1957; revised September 8, 1960.

ST. JACOB FIELD

Operator: Mississippi River Fuel Corporation.

Location: Southeast part of Madison County about 24 miles east of East St. Louis.

History: The St. Jacob oil pool was discovered in 1942. Up to the end of 1959, some 53 producing wells had been drilled, of which 40 were still producing at the end of 1959. Production is from the Trenton Limestone at the approximate depth of 2260 feet. A structure map of the St. Jacob field is shown in figure 13 by contours on top of the Trenton Limestone.

On the crest of the south dome the top of the St. Peter Sandstone is at a depth of 2850 feet and is approximately 100 feet thick. Six wells have been drilled into the St. Peter Sandstone. Based on tests of cores, total storage capacity in the St. Peter reservoir in the south dome has been estimated at 33 billion cubic feet. The capacity of the north dome is less.

An application for authorization to construct an 18-inch service pipeline, 95 miles long, from the Trunkline Gas pipeline at Johnsonville to the St. Jacob storage field is before the Federal Power Commission. This line will continue west from the storage field to St. Louis. It will connect with Illinois Power Company and Laclede Gas Company lines.

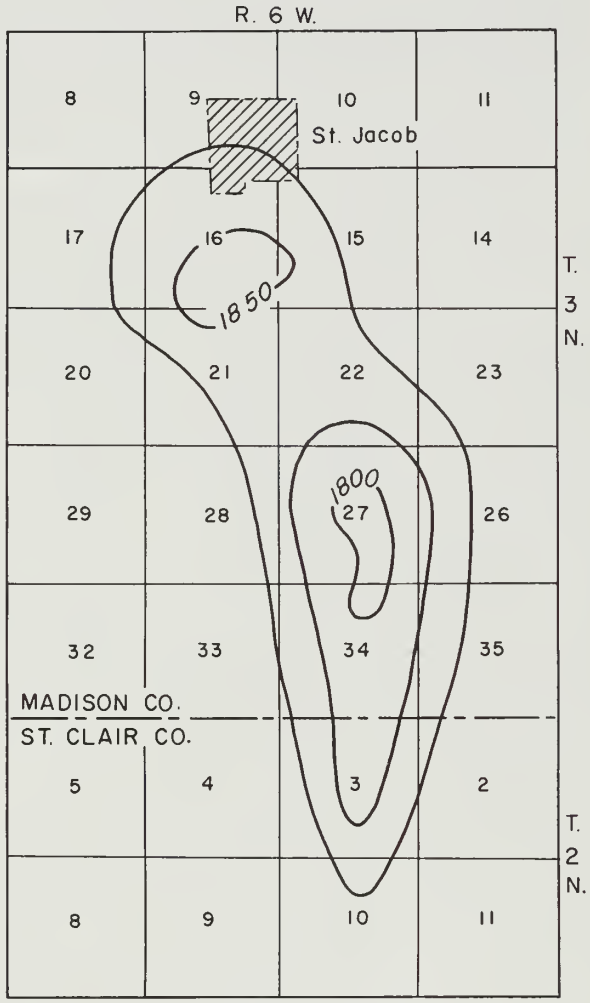

Fig. 13 – St. Jacob gas storage field (after map by Mississippi River Fuel Corporation, January 25, 1960).

WATERLOO STORAGE FIELD

Operator: Mississippi River Fuel Corporation.
Location: Monroe County, 15 miles south of East St. Louis.
History: The Waterloo oil pool was discovered in 1920 and was abandoned in 1930; production was from Trenton Limestone at the approximate depth of 410 feet. The pool was revived in 1939 and was converted to gas storage in 1951. Eleven injection and withdrawal wells, of which eight are in use, were drilled into the Roubidoux (New Richmond) and Gasconade (Oneota) Formations of Ordovician age to the depth of 1,450 or 1,500 feet.

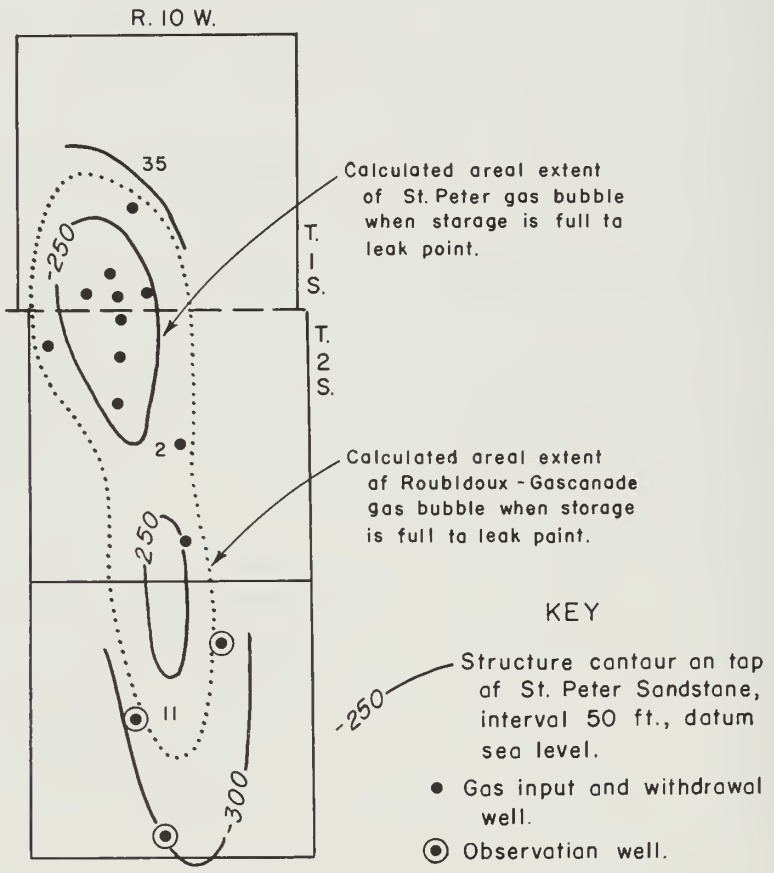

Fig. 14 - Waterloo field, Monroe County, Illinois (after map by Ball Associates, August 1957, by courtesy of Mississippi River Fuel Corporation).

The structure is a fairly sharp anticline trending slightly west of north with a closure of approximately 100 feet on the top of the St. Peter Sandstone (fig. 14). The succession of formations and their thicknesses are shown for a location on top of the structure by the following summary sample study log of a stratigraphic test well:

Mississippi River Fuel Corporation A-15 A. J. Theobald, SW-SE-SW, sec. 35, T. 1 S., R. 10 W., Monroe County
Drilled March 1952

	Thickness (ft.)	Depth (ft.)
No samples	200	200
ORDOVICIAN SYSTEM		
Cincinnatian Series		
Maquoketa Formation		
Shale, dolomitic	170	370
Dolomite, argillaceous	20	390
Mohawkian Series		
Kimmswick Formation		
Limestone	30	420
Dolomite, calcareous	70	490
Decorah Formation		
Limestone, little sand and shale at base	30	520
Plattin Formation		
Limestone, dolomitic, cherty	190	710
Joachim Formation		
Limestone	20	730
Dolomite, calcareous; little green shale	154	884
Glenwood Formation		
Sandstone, shaly	17	901
Chazy Series		
St. Peter Formation		
Sandstone	52	953
Everton Formation		
Sandstone and dolomite interbedded	127	1080
Prairie du Chien (Canadian) series		
Powell (Shakopee) Formation		
Dolomite, sandy; little shale	156	1236
Cotter (Shakopee) Formation		
Dolomite, sandy	62	1298
Jefferson City (Shakopee-New Richmond) Formation		
Dolomite, cherty	60	1358
Roubidoux (New Richmond) Formation		
Dolomite, cherty, slightly sandy	89	1447
Gasconade-Van Buren (Oneota) Formation		
Dolomite, cherty	358	1805
CAMBRIAN SYSTEM		
St. Croixan Series		
Emminence (Trempealeau) Formation		
Dolomite, vuggy, cherty	125	1930
Potosi (Trempealeau) Formation		
Dolomite-vugs lined with quartz and calcite; some banded chert	325	2255
Derby-Doe Run (Franconia) Formation		
Dolomite, argillaceous	135	2390

Cambrian System, continued		
Davis (Franconia) Formation		
Dolomite, sandy; some shale and glauconite	86	2476
Bonne Terre (Eau Claire) Formation		
Dolomite, sandy, glauconitic	274	2750
PRECAMBRIAN		
Granite, red	17	2767
Total Depth		2767

At the beginning of 1959, 449,723 Mcf of gas was in storage. Total injected during 1959 was 1,185,904 Mcf and total withdrawn was 1,160,469 Mcf, with a net increase of gas in storage of 25,435 Mcf. The maximum withdrawn in one day was 20,614 Mcf. The amount of gas in storage at the end of 1960 was 206,000 Mcf. The maximum pressure that could be used without leakage was 550 psi.

Because of the small capacity of the reservoir, it was not practical for seasonal storage, but it serves a useful function for daily injections and withdrawals which take care of the night and day variations in demand. In this way, it serves in the manner of a surge tank.

Gas for injection into the Waterloo storage field is brought from the company's trunk pipeline, $1\frac{1}{2}$ miles to the west, by a 6-inch pipeline.

FREEBURG GAS STORAGE FIELD

Operator: Illinois Power Company, 500 South 27th Street, Decatur, Illinois.

Location: St. Clair County, eight miles southeast of Belleville.

Geologic Information: The Freeburg pool was discovered in 1956 as a natural gas field with no commercial production. After a detailed drilling program, the Illinois Power Company exercised its option to purchase the gas in place and the storage rights.

The exploration program included 21 core tests around the perimeter and the drilling of 24 wells which were completed in a manner that would permit their use as injection or producing wells. These wells provided the basic data necessary to estimate the amount of gas in place and the feasibility of underground storage.

An additional 44 wells were drilled during 1959 and 1960 and completed in a similar manner to finish the development program. Five observation wells were drilled around the perimeter of the storage area during this period for a total of 68 service wells and five observation wells in the entire project.

The gas reservoir is the Cypress sand, which is of the Chester Group and Mississippian in age. The local structure of the sand body is monoclinal, shaling out to the north, west, and south. The usual regional dip to the east is present as the sand thickens and becomes saturated with water.

The maximum thickness of the Cypress sand in the gas productive area of some 2,400 acres is 47 feet and the top is 308 feet from the surface at its highest point. The "caprock" or barrier to migration of oil is a 16- to 28-foot shale between the top of the Cypress Sandstone and the bottom of the Barlow Limestone.

The open-flow potential of the wells has averaged 2,000 Mcf per day with a maximum of 4,500 Mcf per day. The bottom-hole pressure was 165 psi. The volume of gas in place, reduced to atmospheric pressure, was estimated to be 6,400,000 Mcf.

Figure 15 is a contour map of the base of the Beech Creek (Barlow) Limestone (Meents, 1959).

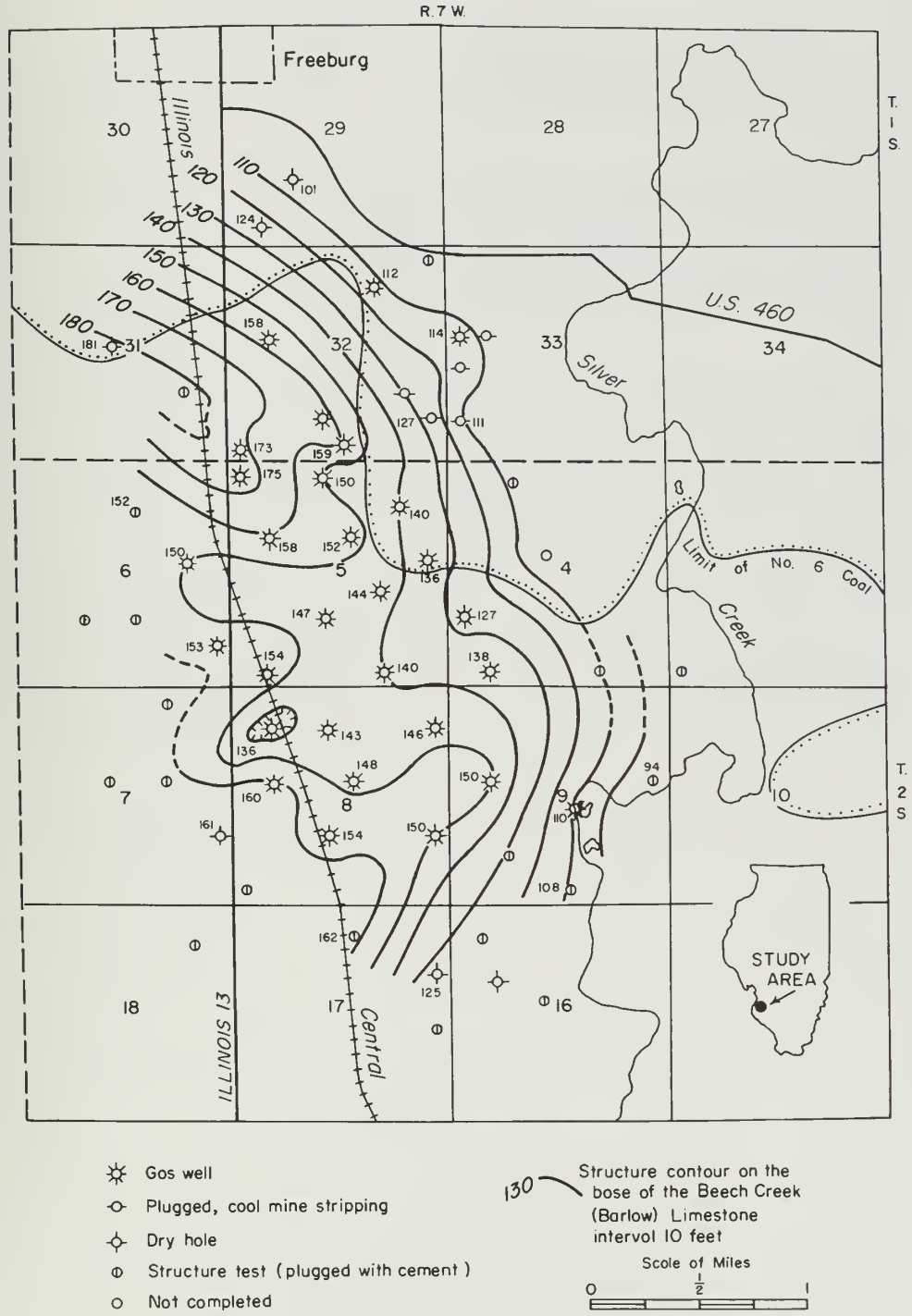

Fig. 15 - Structure of base of the Beech Creek (Barlow) Limestone at Freeburg Gas pool (Illinois Geol. Survey Circ. 272, fig. 3).

Operation: To supplement the gas in place, additional gas is purchased from Mississippi River Fuel Corporation during summer months and, as the demand will allow, during the rest of the year.

Injection was commenced during August 1959, and it is anticipated that a maximum of 15,000 Mcf per day at a pressure of 180 psi will be injected through the 68 wells. The ultimate withdrawal rate is expected to be 30,000 Mcf per day.

In addition to installing a field gathering and injection system and dehydrating and compressor facilities, five miles of 18-inch and nine miles of 14-inch line have been laid from the storage area to the existing distribution system at Belleville. This new line has been designed also to handle gas from the proposed storage project in the Tilden field, which is discussed in this report.

TABLE 9 - FREEBURG GAS STORAGE

	Injection Mcf	Withdrawal Mcf
1959	169,985	180,643
January 1960	22,446	32,714
February	28,204	215,877
March	0	88,900
April	115,266	0
May	98,128	1,229
June	0	0
July	0	0
August	25,580	0
September	112,349	0
October	32,059	4,518
November	34,666	7,363
December	25,757	111,101
Total	664,440	642,345

The net balance in storage as of January 1, 1961, was 22,095 Mcf.

The cost of storage gas at Belleville, when demand charges are considered, is about equal to that of the same volume of gas if it were available and could be purchased by Illinois Power Company at existing rates.

Table 9 gives the injection and withdrawal volumes since initiation of the project.

NORTH TILDEN GAS STORAGE FIELD

Operator: Illinois Power Company, 500 South 27th Street, Decatur, Illinois.

Location: At the junction of St. Clair, Washington, and Randolph Counties, 23 miles southeast of Belleville and 15 miles southeast of the Freeburg Storage Project.

Geologic Information: The North Tilden pool was discovered in 1957 as a natural gas field with no commercial oil production. It was purchased under option by the Illinois Power Company but the exploratory program is still being conducted and little information is available for publication at this time.

To January 1, 1961, 24 wells have been drilled and completed as both injection and producing wells.

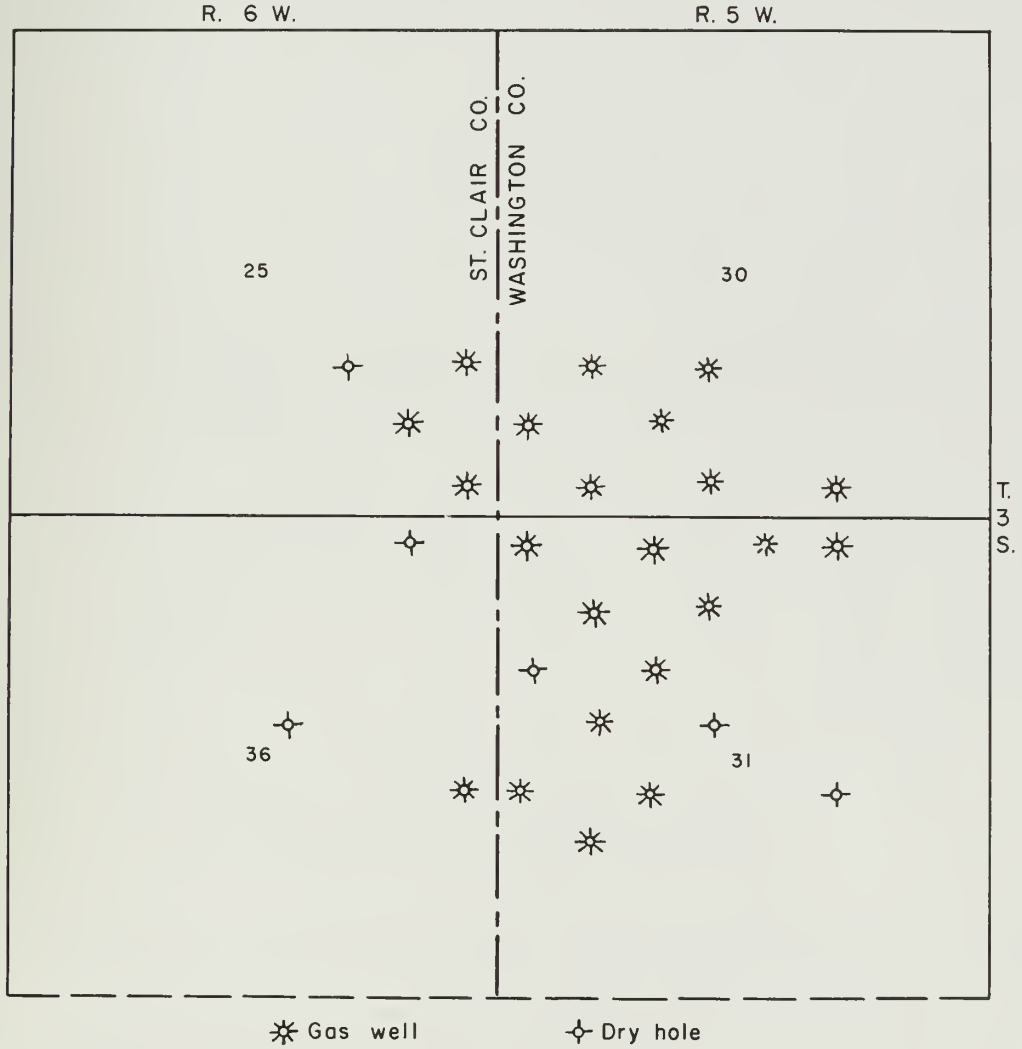

Fig. 16 - Tilden North field, gas storage in lenticular Cypress Sandstone. (Data from Illinois Power Company, August 1955).

The gas reservoir is the Cypress sand, which is of the Chester Group and Mississippian in age. The local structure is monoclinal with a shale-out to the north, west, and south. The sand body has the usual regional dip to the east and becomes water saturated.

Within the present projected storage area of about 500 acres the Cypress has a maximum thickness of 33 feet and is 785 feet from the surface at its highest point. The "caprock" or migration barrier is the shale body between the top of the Cypress and the bottom of the Barlow Limestone. The average thickness of this formation is 20 feet.

The open-flow potential, at the bottom-hole pressure of 330 psi, has averaged 6,000 Mcf per day with a maximum of 11,500 Mcf. Since the project is still under development, the amount of gas in place has not yet been determined.

Figure 16 is a map of the Tilden North storage area showing the location of injection and withdrawal wells in the Cypress Formation.

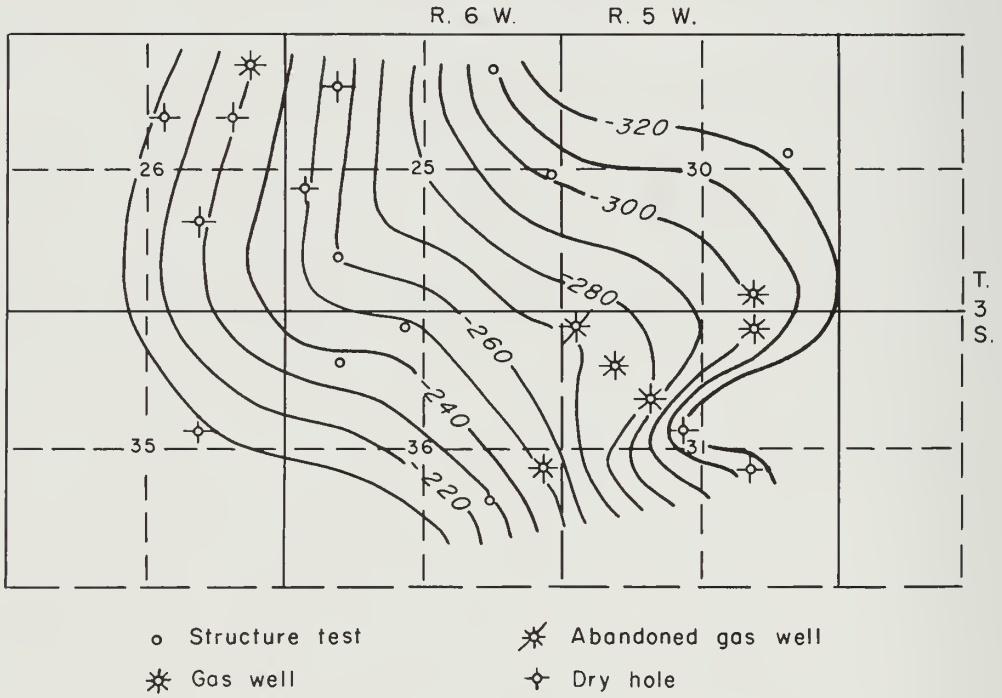

Fig. 17 - Structure of top of Cypress Sandstone in Tilden North field in St. Clair, Washington, and Randolph Counties, Illinois (after map by James A. Lewis Engineering, Inc.).

Operation: When operation of the project is begun, it is expected that 15,000 Mcf per day will be injected at 360 psi. The ultimate withdrawal rate is estimated to be 30,000 Mcf per day.

In addition to the field gathering and injection system, and dehydrating and compressing facilities, 15 miles of 16-inch line will be laid from North Tilden to the Freeburg field. This will allow the use of the new Belleville-Freeburg line to serve the North Tilden operation.

The total investment in the North Tilden project is expected to be some $4,500,000 and will have about the same economic justification as the Freeburg project.

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27 p., 17 figs., 9 tables, 1961

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